teenth century deserves mention. This was the vegetation theory, especially advocated by Tournefort and Camerarius, both eminent as botanists. These writers believed that the seeds of minerals and fossils were diffused throughout the sea and the earth, and were developed into their peculiar forms by the regular increment of their particles, similar to the formation of crystals. "How could the *Cornu Ammonis*," Tournefort asked, "which is constantly in the figure of a volute, be formed without a seed containing the same structure in the small, as in the larger forms? Who moulded it so artfully, and where are the moulds?" The stalactites which formed in caverns in various parts of the world were also supposed to be proofs of this vegetative growth. Still another theory has been held at various times, and is not yet entirely forgotten, namely: that the Creator made fossil animals and plants just as they are found in the rocks, in pursuance of a plan beyond our comprehension. This theory has never prevailed among those familiar with scientific facts, and hence needs here no further consideration. * * *

FOSSILS DEPOSITED BY THE DELUGE.

During the seventeenth century there was a considerable advance in the study of fossil remains. The discussions in regard to the nature and origin of these objects had called attention to them, and many collections were now made, especially in Italy, and also in Germany, where a strong interest in this subject had been aroused. Catalogues of these collections were not unfrequently published, and some of them were illustrated with such accurate figures, that many of the species can now be readily recognized. In this century, too, an important step in advance was made by the collection and description of fossils from particular localities and regions, in distinction from general collections of curiosities. * * *

Besides the authors I have mentioned, there were many others who wrote about fossil remains before the close of the seventeenth century, and took part in the general discussion as to their nature and origin. During the progress of this controversy the most fantastic theories were broached and stoutly defended, and although refuted from time to time by a few clear-headed men, continually sprang up anew, in the same or modified forms. The influence of Aristotle's views of equivocal generation, and especially the scholastic tendency to disputation, so prevalent during the middle ages, had contributed largely to the retardation of progress, and yet a real advance in knowledge had been made. The long contest in regard to the nature of fossil remains was essentially over, for the more intelligent opinion at the time now acknowledged that these objects were not mere "sports of Nature," but had once been endowed with life. At this point, therefore, the first period in the history of Palæontology, as I have indicated it, may appropriately end.

It is true that later still the old exploded errors about the plastic force and fermentation were from time to time revived, as they have been almost to the present day; but learned men, with few exceptions, no longer seriously questioned that fossils were real organisms, as the ancients had once believed. The many collections of fossils that had been brought together, and the illustrated works that had been published about them, were a foundation for greater progress, and, with the eighteenth century, the second period in the history of Palæontology began.

The main characteristic of this period was the general belief that fossil remains were deposited by the Mosaic deluge. We have seen that this view had already been advanced, but it was not till the beginning of the eighteenth century that it became the prevailing view. This doctrine was strongly opposed by some courageous men, and the discussion on the subject soon became even more bitter than the previous one, as to the nature of fossils.

In this diluvial discussion theologians and laymen alike took part. For nearly a century the former had it all their own way, for the general public, then as now, believed what they were taught. Noah's flood was thought to have been universal, and was the only general catastrophe of which the people of that day had any knowledge or conception.

The scholars among them were of course familiar with the accounts of Deucalion and his ark, in a previous deluge, as we are to-day with similar traditions held by various races of men. The firm belief that the earth and all it contains was created in six days; that all life on the globe was destroyed by the deluge, excepting alone what Noah saved; and that the earth and its inhabitants were to be destroyed by fire, was the foundation on which all knowledge of the earth was based. With such fixed opinions, the fossil remains of animals and plants were naturally regarded as relics left by the flood described in Holy Writ. The dominant nature of this belief is seen in nearly all the literature in regard to fossils published at this time, and some of the works which then appeared have become famous on this account.

In 1710, David Büttner published a volume entitled "*Rudera Diluvii Testes*." He strongly opposed Lhwyd's explanation of the origin of fossils, and referred these objects directly to the Flood. The most renowned work, however, of this time, was published at Zurich, in 1726, by Scheuchzer, a physician and naturalist, and professor in the University of Altorf. It bore the title "*Homo Diluvii Testis*." * * *

The above works, however, are hardly fair examples of the literature of fossils during this part of the eighteenth century. Scheuchzer had previously published his well-known "Complaint and Vindication of the Fishes," illustrated with good plates. Moro, in his work on "Marine Bodies which are found in the Mountains," 1740, showed the effects of volcanic action in elevating strata, and causing faults. Vallisneri had studied with care the marine deposits of Italy. Donati, in 1750, had investigated the Adriatic, and ascertained by soundings that shells and corals were being imbedded in the deposits there, just as they were found in the rocks. * * *

VOLTAIRE, BUFFON AND LINNÆUS.

Voltaire (1694-1778), discussed geological questions and the nature of fossils in several of his works, but his published opinions are far from consistent. He ridiculed effectively and justly the cosmogonists of his day, and showed, also, that he knew the true nature of organic remains. Finding, however, that theologians used these objects to confirm the Scriptural account of the deluge, he changed his views, and accounted for fossil shells found in the Alps, by suggesting that they were Eastern species, dropped by the pilgrims on their return from the Holy Land!

Buffon, in 1749, published his important work on Natural History, and included in it his "Theory of the Earth," in which he discussed, with much ability, many points in Geology. Soon after the book was published, he received an official letter from the Faculty of Theology in Paris, stating that fourteen propositions in his works were reprehensible, and contrary to the creed of the Church. The first objectionable proposition was as follows: "The waters of the sea have produced the mountains and valleys of the land—the waters of the heavens reducing all to a level, will at last deliver the whole land over to the sea, and the sea successively prevailing over the land, will leave dry new continents like those we inhabit."

Buffon was politely invited by the college to recant, and having no particular desire to be a martyr to science, submitted the following declaration, which he was required to publish in his next work: "I declare that I had no intention to contradict the text of Scripture; that I believe most firmly all therein related about the creation, both as to order of time and matter of fact; and I abandon everything in my book respecting the formation of the earth, and, generally, all which may be contrary to the narration of Moses."

This single instance will suffice to indicate one great obstacle to the advancement of science, even up to the middle of the eighteenth century. * * *

Abraham Gottlieb Werner (1750-1817), Professor of Mineralogy at Freyberg, did much to advance the science of Geology, and indirectly, that of fossils. He first indicated the relations of the main formations to each other, and, according to his pupil, Professor Jameson, first made the highly important observation "that different formations can be discriminated by the petrifactions they contain." Moreover, "that the petrifactions contained in the oldest rocks are very different from any of the species of the present time; that the newer the formation, the more do the remains approach in form to the organic beings of the present creation." Unfortunately Werner published little, and his doctrines were mainly disseminated by his enthusiastic pupils.

The great contest between the Vulcanists and the Neptunists started at this time, mainly through Werner, whose doctrines led to the controversy. The comparative merits of fire and water, as agencies in the formation of certain rocks, were discussed with a heat and acrimony characteristic of the subject and the time. Werner believed in the aqueous theory, while the igneous theory was especially advocated by Hutton, of Edinburgh, and his illustrator, Playfair. This discussion resulted in the advancement of descriptive geology, but the study of fossils gained little thereby.

The "Protogæa" of Leibnitz, the great mathematician, published in 1749, about thirty years after his death, was a work of much merit. This author supposed that the earth had gradually cooled from a state of igneous fusion, and was subsequently covered with water. The subsidence of the lower part of the earth, the deposits of sedimentary strata from inundations, and their induration, as well as other changes, followed. All this he supposed to have been accomplished in a period of six natural days. In the same work Leibnitz shows that he had examined fossils with considerable care.

Linnæus (1707-1778), the famous Swedish botanist, and the founder of the modern system of nomenclature in Natural History, confined his attention almost entirely to the living forms. Although he was familiar with the literature of fossil remains, and had collected them himself, he did not include them in his system of plants and animals, but kept them separate, with the minerals; hence he did little directly to advance this branch of science.

During the last quarter of the eighteenth century, the belief that fossil remains were deposited by the Deluge sensibly declined, and the dawn of a new era gradually appeared. Let us pause for a moment here, and see what real progress had been made; what foundation had been laid on which to establish a science of fossil remains.

The true nature of these objects had now been clearly determined. They were the remains of animals and plants. Most of them certainly were not the relics of the Mosaic Deluge, but had been deposited long before, part in fresh water and part in the sea. Some indicated a mild climate, and some the tropics. That any of these were extinct species was as yet only suspected. Large collections of fossils had now been made, and valuable catalogues, well illustrated, had been published. Something was known, too, of the geological position of fossils. Steno, long before, had observed that the lowest rocks were without life. Lehmann had shown that above these primitive rocks, and derived from them, were the secondary strata, full of the records of life, and above these were alluvial deposits, which he referred to local floods and the Deluge of Noah. Rouelle, Fuchsel and Odoardi had shed new light on this subject. Werner had distinguished the transition rocks, containing fossil remains, between the primitive and the secondary, while everything above the chalk he grouped together as "The overflowed land." Werner, as we have seen, had done more than this, if we give him the credit his pupils claim for him. He had found that the formations he had examined contained each its own peculiar fossils, and from the older to the newer there was a gradual approach to recent forms. William Smith had worked out the same thing in England, and should equally divide the honor of this important discovery.

The greatest advance, however, up to this time, was that men now preferred to observe, rather than to believe, and facts were held in greater esteem than vague speculations. With this preparation for future progress, the second period in the history of Palæontology, as I have divided it, may appropriately be considered at an end.

FIRST USE OF METHODS IN RESEARCH.

Thus far, I have said nothing in regard to one branch of my subject, the method of Palæontological research, for up to this time, of method there was none. We have seen that those of the ancients who noticed marine shells in the solid rock called them such, and concluded that they had been left there by the sea. The discovery of fossils led directly to theories of how the earth was formed. Here the progress was slow. Subterranean spirits were supposed to guard faithfully the mysteries of the earth; while above the earth, authority guarded with still greater power the secrets men in advance of their age sought to know. The dominant idea of the first sixteen centuries of the present era was, that the universe was made for Man. This was the great obstacle to the correct determination of the position of the earth in the universe, and later, of the age of the earth. The contest of Astronomy against authority was long and severe, but the victory was at last with science. The contest of Geology against the same power followed, and continued almost to our day. The result is still the same. In the early stages of this contest there was no strife, for science was benumbed by the embrace of superstition and creed, and little could be done till that was cast off. In a superstitious age, when every natural event is referred to a supernatural cause, science cannot live; and often as the sacred fire may be kindled by courageous far-seeing souls, will it be quenched by the dense mists of ignorance around it. Scarcely less fatal to the growth of science is the age of Authority, as the past proves too well. With freedom of thought, came definite knowledge, and certain progress;—but 2,000 years was long to wait.

With the opening of the present century, began a new era of Palæontology, which we may here distinguish as the third period in its history. This branch of knowledge became now a science. Method replaced disorder, and systematic study superseded casual observation. For the next half century the advance was continuous and rapid. One characteristic of this period was the accurate determination of fossils by comparison with living forms. This will separate it from the two former epochs. Another distinctive feature of this period was the general belief that every species, recent and extinct, was a separate creation.

At the very beginning of the epoch we are now to consider, three names stand out in bold relief: Cuvier, Lamarck and William Smith. To these men, the science of Palæontology owes its origin. Cuvier and Lamarck, in France, had all the power which great talent, education and station could give; William Smith, an English surveyor, was without culture or influence. The last years of the eighteenth century had been spent by each of these men in preparation for his chosen work, and the results were now given to the world. Cuvier laid the foundation of the Palæontology of Vertebrate animals; Lamarck, of the Invertebrates; and Smith established the principles of Stratigraphical Palæontology. The investigator of fossils to-day seldom needs to consult earlier authors of the science.

George Cuvier (1769-1832), the most famous naturalist of his time, was led to the study of extinct animals by ascertaining that the remains of fossil elephants he examined were extinct species. "This idea," he says later, "which I announced to the Institute in the month of January, 1796, opened to me the views entirely new respecting the theory of the earth, and determined me to devote myself to the long researches and to the assiduous labors which have now occupied me for twenty-five years." * * *

It is interesting to note here that in this first investigation of fossil vertebrates, Cuvier employed the same method that gave him such important results in his later researches. Remains of elephants have been known to Europe for centuries, and many authors, from Pliny down to the contemporaries of Cuvier, had written about them. Some had regarded the bones as those of human giants, and those who recognized what they were considered them remains of the elephants imported by Hannibal or the Romans. Cuvier, however, compared the fossils directly with the bones of existing elephants, and proved them to be distinct. The fact that these remains belonged to extinct species was of great importance. In the case of fossil shells, it was difficult to say that any particular form was not living in a distant ocean; but the two species of existing elephants, the Indian and the African, were well known, and there was hardly a possibility that another living one would be found. * * *

The law of "Correlation of Structures," as laid down by Cuvier, has been more widely accepted than almost anything else that bears his name; and yet, although founded in truth, and useful within certain limits, it would certainly lead to serious error if applied widely in the way he proposed. In his Discourse he sums this law as follows: "A claw, a shoulder blade, a condyle, a leg or arm bone, or any other bone separately considered, enables us to discover the description of teeth to which they have belonged; so also reciprocally we may determine the form of the other bones from the teeth. Thus, commencing our investigation by a careful survey of any one bone itself, a person who is sufficiently master of the laws of organic structure, may, as it were, reconstruct the whole animal to which that bone had belonged." * * *

LAMARCK AND EVOLUTION.

Jean Lamarck (1744-1829), the philosopher and naturalist, a colleague of Cuvier, was a learned botanist before he became a zoologist. His researches on the invertebrate fossils of the Paris Basin, although less striking, were not less important than those of Cuvier on the vertebrates; while the conclusions he derived from them form the basis of modern biology. Lamarck's method of investigation was the same, essentially, as that used by Cuvier, namely, a direct comparison of fossils with living forms. In this way he soon ascertained that the fossil shells imbedded in the strata beneath Paris were, many of them, extinct species, and those of different strata differed from each other. His first memoir on this subject appeared in 1802, and, with his later works, effected a revolution in conchology. His "System of Invertebrate Animals" appeared the year before, and his famous "Philosophie Zoologique" in 1809. In these two works, Lamarck first announced the principles of Evolution. In the first volume of his "Natural History of Invertebrate Animals" he gave his theory in detail; and to-day one can only read with astonishment his far-reaching anticipations of modern science. These views were strongly supported by Geoffroy Saint-Hilaire, but bitterly opposed by Cuvier; and their great contest on this subject is well known.

In looking back from this point of view, the philosophical breadth of Lamarck's conclusions, in comparison with those of Cuvier, is clearly evident. The invertebrates on which Lamarck worked offered less striking evidence of change than the various animals investigated by Cuvier; yet they led Lamarck directly to Evolution, while Cuvier ignored what was before him on this point, and rejected the proof offered by others. Both pursued the same methods, and had an abundance of materials on which to work, yet the facts observed induced Cuvier to believe in catastrophes; Lamarck, in the uniform course of nature. Cuvier declared species to be permanent; Lamarck, that they were descended from others. Both men stand in the first rank of science; but Lamarck was the prophetic genius, half a century in advance of his time.

While the Paris Basin was yielding such important results for Palæontology, its geological structure was being worked out with great care. The results appeared in a volume by Cuvier and Alex. Brongniart, chiefly the work of the latter, published in 1808. This was the first systematic investigation of Tertiary strata. Three years later, the work was issued in a more extended form. The separate formations were here carefully distinguished by their fossils, the true importance of which for this purpose being distinctly recognized. This advance was not accepted without some opposition, and it is an interesting fact that Jameson, who claimed for Werner the theory here put in practice, rejected its application, and wrote as follows: "To Cuvier and Brongniart we are indebted for much valuable information in their description of the country around Paris, but we must protest against the use they have made of fossil organic remains in their geognostical descriptions and investigations."

William Smith (1769-1839), "the father of English Geology," had previously published a "Tabular View of the British Strata." He appears to have arrived independently at essentially the same view as Werner in regard to the relative position of stratified rocks. He had determined that the order of succession was constant, and that the different formations might be identified at distant points by the fossils they contained. In his later works, "Strata identified by Organized Fossils," published in 1816-'20 and "Stratigraphical System of Organized Fossils," 1817, he gave to the world results of many years of careful investigations on the Secondary formations of England. In the latter work he speaks of the success of his method in determining strata by their fossils, as follows: "My original method of tracing the strata by the organized fossils imbedded therein, is thus reduced to a science not difficult to learn. Ever since the first written account of this discovery was circulated in 1799, it has been closely investigated by my scientific acquaintances in the vicinity of Bath, some of whom search the quarries of different strata in that district with as much certainty of finding the characteristic fossils of the respective rocks as if they were on the shelves of their cabinets." * * *

William Buckland (1784-1856) published in 1823 his celebrated "Reliquiæ Diluvianæ," in which he gave the result of his own observations in regard to the animal remains found in the caves, fissures and alluvial gravels of England. The facts presented are of great value, and the work was long a model for similar researches. Buckland's conclusions were that none of the human remains discovered in the caves were as old as the extinct mammals found with them, and that the Deluge was universal. In speaking of fossil bones found in the Himalaya Mountains, he says: "The occurrence of these bones at such an enormous elevation in the region of eternal snow, and consequently in a spot now unfrequented by such animals as the horse and deer, can, I think, be explained only by supposing them to be of antediluvian origin, and that the carcasses of the animals were drifted to their present place and lodged in sand by the diluvial waters."

The foundation of the "Geological Society of London," in 1807, marks an important point in the history of Palæontology. To carefully collect materials for future generalizations, was the object in view, and this organization gradually became the centre in Great Britain for those interested in geological science. The society was incorporated in 1826, and has since been the leading organization in Europe for the advancement of the sciences within its field. The Geological Society of France, established at Paris in 1832, and the German Geological Society, founded in Berlin in 1848, have likewise contributed largely to geological investigations in these countries, and to some extent in other parts of the world. In the publications of these three societies, the student of Palæontology will find a mine of valuable materials for his work. * * *

LOUIS AGASSIZ—OWEN.

The impetus given by Cuvier to the study of vertebrate fossils extended over Europe, and great efforts were made to continue discoveries in the direction he had so admirably pointed out.

Louis Agassiz (1807-'73), a pupil of Cuvier, and long an honored member of this association, attained eminence in the study of ancient as well as of recent life. His great work on Fossil Fishes deserves to rank next to Cuvier's "Ossemens Fossiles." The latter contained mainly fossil mammals and reptiles, while the fishes were left without a historian till Agassiz began his investigations. His studies had admirably fitted him for the task, and his industry brought together a vast array of facts bearing on the subject. The value of this grand work consists not only in its faithful descriptions and plates, but also in the more profound results it contained. Agassiz first showed that there is a correspondence between the succession of fishes in the rocks, and their embryonal development. This is now thought to be one of the strongest points in favor of evolution, although its author interpreted the facts as bearing the other way.

Pander's memoirs on the fossil fishes of Russia form a worthy supplement to Agassiz's classic work. Brandt's publications are likewise of great value; and those of Lund, in Sweden, have an especial interest to Americans, in consequence of his researches in the caves of Brazil.

The brilliant discoveries of Cuvier in the Paris Basin excited great interest in England, and when it was found that the same Tertiary strata existed in the south of England, careful search was made for vertebrate fossils. Remains of some of the same genera described by Cuvier were soon discovered, and other extinct animals new to science were found in various parts of the Kingdom. König, to whom we owe the name *Ichthyosaurus*, and Conybeare, who gave the generic designation *Plesiosaurus*, and also *Mosasaurus*, were among the earliest writers in England on fossil reptiles. The discovery of these three extinct types, and the discussion as to their nature, forms a most interesting chapter in the annals of Palæontology. The discovery of the *Iguanodon* by Mantell and the *Megalosaurus* by Buckland excited still higher interest. These great reptiles differed much more widely from living forms than the mammals described by Cuvier, and the period in which they lived soon became known as the "age of Reptiles." The subsequent researches of these authors added largely to the existing knowledge of various extinct forms, and their writings did much to arouse public interest in the subject.

Richard Owen, a pupil of Cuvier, followed, and brought to bear upon the subject an extensive knowledge of comparative anatomy, and a wide acquaintance with existing forms. His contributions have enriched almost every department of Palæontology, and of extinct vertebrates especially, he has been, since Cuvier, the chief historian. The fossil reptiles of England he has systematically described, as well as those of South Africa. The extinct Struthious birds of New-Zealand he has made known to science, and accurately described in extended memoirs. His researches on the fossil mammals of Great Britain, the extinct Edentates of South America, and the ancient Marsupials of Australia, each forms an important chapter in the history of our science. * * *

It may be interesting here to note briefly the use of general terms in Palæontology, as the gradual progress of the science was indicated to some extent in its terminology. At first, and for a long time, the name "fossil" was appropriately used for objects dug from the earth, both minerals and organic remains. The term "Oryctology," having essentially the same meaning, was also used for this branch of study. For a long period, too, the termination "ites" (*lithos*, a stone) was applied to fossils to distinguish them from the corresponding living forms; as, for instance, "Ostracites," used by Pliny. At a later date, the general name "figured stones" (*lapides figurati*) was extensively used; and less frequently, "Deluge stones" (*lapides diluviani*). The term "organized fossils" was used to distinguish fossils from minerals, when the real difference became known, although the name "Reliquiæ" was sometimes employed. The term "petrifactions" (*Petrificata*) was defined by John Gesner in his work on fossils in 1758, and was afterward extensively used. Palæontology is comparatively a modern term, having come into use only within the last half century. It was introduced about 1830, and soon was generally adopted in France and England, but in Germany it met with less favor, though used to some extent. * * *

The third period in the history of Palæontology, which, as I have said, began with Cuvier and Lamarck at the beginning of the present century, forms a natural epoch extending through six decades. The definite characteristics of this period, as stated, were dominant during all this time, and the progress of Palæontology was commensurate with that of intelligence and culture.

For the first half of this period the marvellous discoveries in the Paris Basin excited astonishment and absorbed attention; but the real significance and value of the facts made known by Cuvier, Lamarck and William Smith were not appreciated. There was still a strong tendency to regard fossils merely as interesting objects of natural history, as in the previous period, and not as the key to profounder problems in the earth's history. Many prominent geologists were still endeavoring to identify formations in different countries by their mineral characters, rather than by the fossils imbedded in them. Such names as "Old Red Sandstone," and "New Red Sandstone," were given in accordance with this opinion. Humboldt, for example, attempted to compare the formations of South America and Europe by their mineral features, and doubted the value of fossils for this purpose. In 1823, he wrote as follows: "Are we justified in concluding that all formations are characterized by particular species? that the fossil shells of the chalk, the muschelkalk, the Jura limestone, and the Alpine limestones are all different? I think this would be pushing the induction much too far." Jameson still thought minerals more important than fossils for characterizing formations; while Bakewell, later yet, defines Palæontology as comprising "Fossil Zoölogy and Fossil Botany, a knowledge of which may appear to the student as having little connection with Geology."

GEOLOGY AS A SCIENCE—DARWIN.

During the latter half of the third period greater progress was made, and before its close Geology was thoroughly established as a science. Let us consider for a moment what had really been accomplished up to this time.

It had now been proved beyond question that portions at least of the earth's surface had been covered many times by the sea, with alternations of fresh water and of land; that the strata thus deposited were found in succession, the lowest of the series being the oldest; that a distinct succession of animals and plants had inhabited the earth during the different geological periods; and that the order of succession found in one part of the earth was essentially the same in all. More than 30,000 new species of extinct animals and plants had now been described. It had been found, too, that from the oldest formations to the most recent there had been an advance in the grade of life, both animal and vegetable, the oldest forms being among the simplest, and the higher forms successively making their appearance.

It had now become clearly evident, moreover, that the fossils from the older formations were all extinct species, and that only in the most recent deposits were there remains of forms still living. The equally important fact had been established, that in several groups of both animals and plants, the extinct forms were vastly more numerous than the living; while several orders of fossil animals had no representatives in modern times. Human remains had been found mingled with those of extinct animals, but the association was regarded as an accidental one by the authorities in science; and the very recent appearance of Man on the earth was not seriously questioned. Another important conclusion reached, mainly through the labors of Lyell, was, that the earth had not been subjected in the past to sudden and violent revolutions; but the changes wrought had been gradual, differing in no respect from those still in progress. Strangely enough, the corollary to this proposition, that Life, too, had been continuous on the earth, formed no part of the stock of knowledge.

In the physical world, the great law of "Correlation of forces" had been announced, and widely accepted; but in the organic world, the dogma of the miraculous creation of each separate species still held sway, almost as completely as when Linnæus declared: "There are as many different species as there were different forms created in the beginning by the Infinite Being." But the dawn of a new era was already breaking, and the third period of Palæontology we may consider now at an end.

Just twenty years ago, science had reached a point when the belief in "special creations" was undermined by well-established facts, slowly accumulated. The time was ripe. Many naturalists were working at the problem, convinced that Evolution was the key to the present and the past. But how had Nature brought this change about? While others pondered, Darwin spoke the magic word—"Natural Selection," and a new epoch in science began.

The fourth period in the history of Palæontology dates from this time, and is the period of to-day. One of the main characteristics of this epoch is the belief that all life, living and extinct, has been evolved from simple forms. Another prominent feature is the accepted fact of the great antiquity of the human race. These are quite sufficient to distinguish this period sharply from those that preceded it.

The publication of Charles Darwin's work on the "Origin of Species," November, 1859, at once aroused attention, and started a revolution which has already, in the short space of two decades, changed the whole course of scientific thought. The theory of "Natural Selection," or, as Spencer has happily termed it, the "Survival of the Fittest," had been worked out independently by Wallace, who justly shares the honor of the discovery. We have seen that the theory of Evolution was proposed and advocated by Lamarck, but it was before his time. The anonymous author of the "Vestiges of Creation," which appeared in 1844, advocated a somewhat similar theory which attracted much attention, but the belief that species were immutable was not sensibly affected until Darwin's work appeared.

The difference between Lamarck and Darwin is essentially this: Lamarck proposed the theory of Evolution; Darwin changed this into a doctrine, which is now guiding the investigations in all departments of biology. Lamarck failed to realize the importance of time, and the interaction of life on life. Darwin, by combining these influences with those also suggested by Lamarck, has shown how the existing forms on the earth may have been derived from those of the past.

This revolution has influenced Palæontology as extensively as any other department of science [illegible] we are discussing. In the last epoch, species were represented independently, by parallel lines; in the present period, they are indicated by dependent, branching lines. The former period was the analytic, the latter the synthetic, period. To-day, the animals and plants now living are believed to be genetically connected with those of the distant past; and the palæontologist no longer deems species of the first importance, but seeks for relationships and genealogies, connecting the distant past with the present. Working in this spirit and with such a method, the advance during the last decade has been great, and is an earnest of what is yet to come. * * *

PALÆONTOLOGY IN AMERICA.

Of the progress of Palæontology in America, I have thus far said nothing, and I need now say but little, as many of you are doubtless familiar with its main features. During the first and second periods in the history of Palæontology, as I have defined them, America, for most excellent reasons, took no part. In the present century, during the third period, appear the names of Bigsby, Green, Morton, Mitchell, Rafinesque, Say and Troost, all of whom deserve mention. More recently, the researches of Conrad, Dana, Deane, DeKay, Emmons, Gibbes, Hitchcock, Holmes, Lea, Owen, Redfield, Rogers, Shumard, Swallow, and many others, have enlarged our knowledge of the fossils of this country.

The contributions of James Hall to the Invertebrate Palæontology of this country form the basis of our present knowledge of the subject. The extensive labors of Meek in the same department are likewise entitled to great credit, and will form an important chapter in the history of the science. The memoirs of Billings, Gabb, Scudder, White, and Whitfield are numerous and important; and the publications of Derby, Hartt, James, Miller, Shaler, Rathburn, and Winchell, are also of value. To Dawson, Lesquereux, and Newberry, we mainly owe our present knowledge of the fossil plants of this country.

The foundation of our Vertebrate Palæontology was laid by Leidy, whose contributions have enriched nearly every department of the subject. The numerous publications of Cope are well known. Agassiz, Allen, Baird, Dawson, Deane, De Kay, Emmons, Gibbes, Harlan, Hitchcock, Jefferson, Lea, Le Conte, Newberry, Redfield, St. John, Warren, Whitney, Worthen, Wyman, and others have all added to our knowledge of American fossil vertebrates. The chief results in this department of our subject I have already laid before you on a previous occasion, and hence need not dwell upon them here.

In this rapid sketch of the history of Palæontology, I have thought it best to speak of the earlier periods more in detail, as they are less generally known, and especially as they indicate the growth of the science, and the obstacles it had to surmount. With the present work in Palæontology, moreover, you are all more or less familiar, as the results are now part of the current literature. To assign every important discovery to its author, would have led me far beyond my present plan. I have only endeavored to indicate the growth of the science by citing the more prominent works that mark its progress, or illustrate the prevailing opinions and state of knowledge at the time they were written.

In considering what has been accomplished, directly or indirectly, it is well to bear in mind that without Palæontology there would have been no science of Geology. The latter science originated from the study of fossils, and not the reverse, as generally supposed. Palæontology, therefore, is not a mere branch of Geology, but the foundation on which that science mainly rests. This fact is a sufficient excuse, if one were wanting, for noting the early opinions in regard to the changes of the earth's surface, as these changes were first studied to explain the position of fossils. The investigation of the latter first led to theories of the earth's formation, and thus to Geology. When speculation replaced observation, fossils were discarded, and for a time the mineral characters of strata were thought to be the key to their position and age. For some time after this, geologists, as we have seen, apologized for using fossils to determine formations, but for the last half century their value for this purpose has been fully recognized.

The services which Palæontology has rendered to Botany and Zoology are less easy to estimate, but are very extensive. The classification of these sciences has been rendered much more complete by the intercalation of many intermediate forms. The probable origin of various living species has been indicated by the genealogies suggested by extinct types; while our knowledge of the geographical distribution of animals and plants at the present day has been greatly improved by the facts brought out in regard to the former distribution of life on the globe.

Among the vast number of new species which have been added are the representatives of a number of new orders entirely unknown among living forms. The distribution of these extinct orders, among the different classes, is interesting, as they are mainly confined to the higher groups. Among the fossil plants, no new orders have yet been found. There are none among the Protozoa or the Mollusca. The Radiates have been enriched by the extinct orders of Blastoidea, Cystidea and Edrioasteridæ; and the Crustaceans by the Eurypterida and Trilobita. Among the Vertebrates, no extinct order of fossil Fishes has yet been found; but the Amphibians have been enlarged by the important order Labyrinthodonta. The greatest additions have been among the Reptiles, where the majority of the orders are extinct. Here we have at the present date the Ichthyosauria, Sauranodontia, Plesiosauria and Mosasauria, among the marine forms; the Pterosauria, including the Pteranodontia, containing the flying forms; and the Dinosauria, including the Sauropoda, the giants among reptiles; likewise the Dicynodontia and probably the Theriodontia, among the terrestrial forms. Although but few fossil Birds have been found below the Tertiary, we have already among the Mesozoic forms three new orders—the Saururæ, represented by *Archæopteryx*; the Odontotormæ, with *Ichthyornis* as the type; and the Odontolcæ, based upon *Hesperornis*; all of these orders being included in the sub-class Odontornithes, or toothed birds. Among Mammals, the new groups regarded as orders are the Toxodontia, and the Dinocerata, among the Ungulates; and the Tillodontia, including strange Eocene Mammals whose exact affinities are yet to be determined.

Among the important results in Vertebrate Palæontology are the genealogies, made out with considerable probability, for various existing animals. Many of the larger mammals have been traced back by well-preserved lines in a closely connected series to early Tertiary times. In several cases the series are so complete that there can be little doubt that the line of descent has been established. The Evolution of the horse, for example, is to-day demonstrated by the specimens now known. The demonstration in such a case stands for all. The evidence in favor of the genealogy of the horse now rests on the same foundation as the proof that any fossil bone once formed part of the skeleton of a living animal. A special creation of a single bone is as probable as the special creation of a single species. The method of the palæontologist in the investigation of the one is the method for the other. The only choice lies between natural derivation and supernatural creation.

For such reasons it is now regarded among the active workers in science as a waste of time to discuss the truth of Evolution. The battle on this point has been fought and won.

The geographical distribution of animals and plants, as well as their migrations, have received much new light from Palæontology. The fossils found in some natural divisions of the earth are related so closely to the forms now living there that a genetic connection between them can hardly be doubted. The extinct Marsupials of Australia, and the Edentates of South America, are well-known examples. The Pliocene hippopotami of Asia and the South of Europe, point directly to migrations from Africa. Other similar examples are numerous. The fossil plants of the Arctic region prove the existence of a climate there far milder than at present, and recent researches render it more probable the suggestion, made long ago by Buffon, in his "Epochs of Nature," that life began in the polar regions, and by successive migrations from there the continents were peopled.

The great services which Comparative Anatomy rendered to Palæontology at the hands of Cuvier, Agassiz, Owen and others, have been amply repaid. The solution of some of the most difficult problems in Anatomy has received scarcely less aid from the extinct forms discovered than from Embryology; and the two lines of research supplement each other. Our present knowledge of the vertebrate skull, the limb-arches, and the limbs, has been mainly derived from researches in Palæontology. [illegible] the recent labors of Gegenbaur, Huxley, Parker, Balfour, and Thacher, will show [illegible] many obscure points in ancient life.

SERVICES RENDERED BY PALÆONTOLOGY.

One of the important results of recent palæontological research is the law of brain-growth, found to exist among extinct mammals, and to some extent in other vertebrates. According to this law, as I have briefly stated it elsewhere, "all Tertiary mammals had small brains. There was also a gradual increase in the size of the brain during this period. This increase was confined mainly to the cerebral hemispheres, or higher portions of the brain. In some groups the convolutions of the brain have gradually become more complicated. In some the cerebellum and olfactory lobes have even diminished in size." More recent researches render it probable that the same general law of brain-growth holds good for birds and reptiles from the Mesozoic to the present time. The Cretaceous birds, that have been investigated with reference to this point, had brains only about one-third as large in proportion as those nearest allied among living species. The Dinosaurs from our Western Jurassic follow the same law, and had brain cavities vastly smaller than in any existing reptiles. Many other facts point in the same direction, and indicate that the general law will hold good for all extinct vertebrates.

Palæontology has rendered great service to the more recent science of Archæology. At the beginning of the present period, a reëxamination of the evidence in regard to the antiquity of the human race was going on, and important results were soon attained. Evidence in favor of the presence of man on the earth at a period far earlier than the accepted chronology of 6,000 years would imply, had been gradually accumulating; but had been rejected from time to time by the highest authorities. In 1823, Cuvier, Brongniart, and Buckland, and later, Lyell, refused to admit that human relics, and bones of extinct animals found with them, were of the same geological age, although experienced geologists, such as Boné and others, had been convinced [illegible]. Christol, Serres, and Tournal, in France, and Schmerling, in Belgium, had found human remains in caves, associated closely with those of various extinct mammals, and other similar facts were on record.

Boucher de Perthes, in 1841, began to collect stone implements in the gravels of the valley of the Somme, and in 1847, published the first volume of his "Antiquités Celtiques." In this work he described the specimens he had found and asserted their great antiquity. The facts as presented, however, were not generally accepted. Twelve years later, Falconer, Evans, and Prestwich examined the same localities with care, and became convinced, and the results were published in 1859 and 1860. About the same time Gaudry, Hébert, and Desnoyers, also explored the same valley, and announced that the stone implements there were as ancient as the mammoth and rhinoceros found with them. Explorations in the Swiss lakes and in the Danish shell heaps added new testimony bearing in the same direction. In 1863, appeared Lyell's work on the "Geological Evidences of the Antiquity of Man," in which facts were brought together from various parts of the world, proving beyond question the great age of the human race.

The additional proof since brought to light has been extensive, and is still rapidly increasing. The Quaternary age of man is now generally accepted. Attempts have recently been made to approximate in years the time of man's first appearance on the earth. One high authority has estimated the antiquity of man since the time of the last glacial epoch of Europe as 250,000 years; but those best qualified to judge, would, I think, regard this as a fair estimate.

Important evidence has likewise been adduced of man's existence in the Tertiary, both in Europe and America. The evidence to-day is in favor of the presence of man in the Pliocene of this country. The proof offered on this point by Professor J. D. Whitney, in his recent work, is so strong, and his careful, conscientious method of investigation so well known, that his conclusions seem inevitable. Whether the Pliocene strata he has explored so fully on the Pacific coast correspond strictly with the deposits which bear this name in Europe, may be a question requiring further consideration. At present, the known facts indicate that the American beds containing human remains, and works of man, are at least as old as the Pliocene of Europe. The existence of Man in the Tertiary period seems now fairly established.

In looking back over the history of Palæontology, it is evident that the work has but just begun. A small fraction only of the earth's surface has been examined, and [illegible]. The "imperfection of the geological record," [illegible]. In filling out this record, America, I believe, will [illegible] her full share, and thus aid in the solution of the great problems now before us.

I have endeavored to define clearly the different periods in the history of Palæontology. If I may venture, in conclusion, to characterize the present period in all departments of science, its main feature would be a belief in universal law. The reign of law, first recognized in the physical world, has now been extended to Life as well. [illegible] inanimate nature the key to her profounder mysteries—Evolution, which embraces the universe.

Is this to be the main characteristic of the next period? No one now can tell. But if we were permitted to continue in imagination the rapidly converging lines of research pursued to-day, they would seem to meet at a point where organic and inorganic nature become one. That this point will yet be reached, I cannot doubt.

The Irishman had a correct appreciation of the fitness of things who, being asked by the judge, when he applied for a license to sell whiskey, if he had a good moral character, replied: "Faith, yer honor, I don't see the necessity of a good moral character to sell whiskey!"

Did you ever know a barber to own up that he had cut you? They never do it; they apply for a chunk of alum and casually remark, "Well, I guess I shaved that spot a trifle too close."—[Waterloo Observer.

THE COURTS.

WILLS PROBATED IN BROOKLYN.

The will of the late ex-Judge Dikeman, of Brooklyn, was offered for probate before Surrogate Dailey, of Kings County, yesterday. It is dated November 13, 1878. The estate is valued at about $80,000. After leaving some minor bequests, the decedent instructs the executors to invest $4,500 for the benefit of his brother, R. B. Dikeman, and $9,000 for Hannah Stryker. The residue of the estate is to be divided into equal portions, one share for each of his living children, and one for the heirs of each of those who are dead. The executors are Joseph M. Pray and Richard Ingraham.

There was likewise offered for probate before Surrogate Dailey, in Brooklyn, yesterday the will of the late Oscar F. Hawley, of No. 105 Bedford-ave. This document is dated June 19, 1878. The executors are the widow, Mrs. Agnes C. Hawley, O. F. Hawley, jr., and Theodore F. Jackson. All the decedent's personal property is bequeathed to his wife. The real estate is left to the executors in trust. They are to pay $1,000 a year to each of the two daughters, and the balance of the income to Mrs. Hawley so long as she shall remain a widow. If she marry only one-fourth of the income of the estate will be paid to her and the remainder to the children. In the event of her death the property is to be equally divided among the five children of the decedent. During the lifetime of Mrs. Hawley the trustees are to rent to O. F. Hawley, jr., the building and moulding mill in Gold-st., this city, for $4,000 a year, and to [illegible] a sum of $31,000 at 6 per cent interest to Edwin C. Hawley. At the division of the estate the latter sum is to be included in the shares of these two sons. The real estate consists of the decedent's homestead, houses in Bedford-ave., Tompkins-ave., Rodney-st., Pacific-st., and other streets in the Eastern District of Brooklyn. The estimated value of the whole is $250,000.

CASES TO BE TRIED AT JERSEY CITY.

Sheriff Toffey, of Jersey City, has drawn the Grand Jury for the September term of the Hudson County courts, which will open on Tuesday next in that city. Judge Knapp, of the Supreme Court and presiding judge of the County courts, is visiting friends in Colorado, and it is not yet known who will preside over the courts until he returns. The most important cases for the approaching term are the new trial of Mrs. Jennie R. Smith and Covert D. Bennett for the murder of Policeman Richard H. Smith and the trial of the officers of the Mechanics and Laborers' Savings Bank, who were indicted for conspiracy to defraud the depositors. [illegible] the lawyers on the part of the State and the defence in the Smith case. District-Attorney McGill is anxious to try the case in the coming term, [illegible] come up. The lawyers employed in the defence are confident of an acquittal, and it is alleged that they have evidence which supports Bennett's alibi.

DECISIONS—AUG. 28.

Supreme Court—Special Term—By Judge Van Brunt.—May agt. Foss and another.—Judgment roll must be presented. Van Pelt, etc., agt. O'Rorke et al.—[illegible]

Common Pleas—Special Term—By Judge Beach.—The Seaman's Bank, etc., agt. Quinn.—[illegible] Margarietta.—Order granted. Schermerhorn agt. Carter.—Motion granted. [illegible] Heyman agt. Strohsal.—Applications granted.

Marine Court—Special Term—By Judge Goepp.—Adams agt. Ryckman.—[illegible] Finster, etc., agt. Hayward agt. Finster, etc. [illegible] Griscom agt. Smith.—Undertaking approved. [illegible] Rose; Hornblower agt. Ghiatti and another; Kamp agt. Woods; Schermerhorn agt. Schroder, etc.; [illegible] Bradt agt. Hammerschmidt.—Orders granted.

By Judge Sinnott.—Stickney agt. Ross; same agt. same.—Orders granted.

CALENDARS THIS DAY.

SUPREME COURT—CHAMBERS—Van Brunt, J.—Court opens at 10:30 a. m. Calendar called at 11 a. m. Nos. 2, 46, 49, 66, 70, 118, 135, 181, 184, 185.

THE WESTERN CROPS.

A LARGE INCREASE IN THE PRODUCTION OF THE NORTHWEST—GOOD REPORTS FROM KANSAS.

CHICAGO, Aug. 27.—*The Daily Commercial Bulletin* issues its annual estimate of the Spring wheat crop of the Northwest to-day. Reports were received from 308 counties in the Western States and Territories, embracing over 8,000,000 acres devoted to the production of Spring wheat. The total acreage is estimated at 10,666,935, against 9,514,739 last year. The average yield per acre is estimated at 12.92 bushels, against 11.42 last year. The aggregate yield is estimated at 137,850,000 bushels, against 108,745,000 last year, showing an increase of 29,105,000 bushels. This is not considered excessive in view of the well known poor crop of last year. The increase in acreage is reported at 12.26 per cent, or equal in the aggregate to 1,152,000 acres in excess of the returns of last year. Of the increase in the crop, about 16,000,000 bushels is due to the increased average yield, and the balance to the development of new lands. The average yield of the different States is reported as follows: Illinois, 11.43; Wisconsin, 13.74; Minnesota, 13.11; Missouri, 12.50; Iowa, 12.20; Nebraska, 12.98; Kansas, 9.33; Dakota, 15.80.

The yield of the different States is estimated as follows: Illinois, 34,730,000 bushels; Minnesota, 36,696,000; Nebraska, 16,422,000; Dakota, 11,100,000; Wisconsin, 21,598,000; Iowa, 40,162,000; Kansas, 3,966,000.

The increase in the yield is about as follows: Minnesota, 7,000,000 bushels; Iowa, 13,000,000; Nebraska, 4,000,000; Wisconsin, 4,000,000; Dakota, 3,000,000. The other States show a slight falling off. The quality is reported generally as very good; better than for some years past.

KANSAS CITY, Mo., Aug. 27.—*The Commercial Indicator* will publish to-morrow special reports from fifty-eight counties in Kansas, thirty-five in Nebraska, eleven in Western Missouri and twelve in Southwestern Iowa. The acreage of corn is generally reported very much larger, and the prospects for a large yield are excellent, although in counties of Kansas and Western Missouri late corn has been somewhat damaged by the weather. There will be a less number of hogs marketed during the next two months than for the same months last year. Hogs are generally in a healthy condition.

There is something passing strange about human nature. If a man had to support his family by playing billiards at $2 a day he'd complain he had to work awful hard for a living.—[Middletown Transcript.

Delicate consideration for the elephant—considerate little girl: "Please, Mr. Keeper, will it hurt him if I give him a currant out of my bun?"